NIOSH FY2006 Project Form – Research Proposal Information

Summary

TITLE OF PROJECT	
Dust Control Technology for Black Lung Hot Spots	
PROJ. OFFICER (Last, first, middle)	**DEGREE(S)**
Pollock, Douglas Edward	B.S. Mechanical Engineering Technology, Licensed Professional Engineer – Commonwealth of Pennsylvania
POSITION TITLE	**MAILING ADDRESS (Street, city, state, zip code)**
Mechanical Engineer	P.O. Box 18070 626 Cochrans Mill Road Pittsburgh, PA 15236
DIVISION/BRANCH	
Respiratory Hazards Control Branch/ Dust Control	
TELEPHONE (Area code, number, and extension)	
(412) 386-6863	
FAX	**E-MAIL ADDRESS**
(412) 386-4917	depollock@cdc.gov

Will this project utilize human subjects?				Will this project utilize vertebrate animals?			
YES:		**NO:**	X	**YES:**		**NO:**	X
				Species of animals to be used:			N/A
				Approximate number of animals to be used:			N/A

DATES OF PROPOSED PERIOD OF SUPPORT (MM/DD/YYYY)		NEW FUNDS REQUIRED (Do not include existing base funding)				
			PS&B	**Other Intramural**	**Extramural**	**Total**
From:	10/1/2005	**FY2006**		$28,000		
Through:	09/30/2009	**All Years**		$98,000		

NEW FTEs	0.0	**% Project Category(s):**	100% Research
CURRENT FTEs	1.8	**% NORA Priority Area(s):**	100% Control Technology and PPE
TOTAL FTEs	1.8	**% Special Interest Areas(s):**	100% Mining
		% GPRA Category(s):	80% Research, 20% Evaluation, Intervention, and Recommendations

DESCRIPTION

Coal Workers' Pneumoconiosis (CWP) is a disabling and potentially fatal lung disease that results from excessive exposure to respirable coal dust. A chest x-ray program is administered by NIOSH that monitors the prevalence of CWP in the mining workforce. Since 1970, underground coal miners have had the opportunity to participate in this program on a voluntary basis. X-ray results from this program indicate that there are large regional differences in the prevalence of CWP, with the highest prevalence for bituminous coal mining found in the southern Appalachian region (SAR). The SAR is comprised of the coalfields of eastern Kentucky, southern West Virginia, and western Virginia. The counties of southern West Virginia have CWP rates at least five times higher than those observed in western and mid-western states.

The exact cause of these elevated CWP levels in the SAR has not been established but several factors may be contributing. Higher-rank coals are mined in a portion of this region, and the mining of high rank coals is known to lead to higher CWP rates. A high fraction of the mines in the region are on reduced standards because of silica and the miners may be exposed to an excessive amount of silica dust. Overexposure to silica dust can lead to silicosis, another disabling and potentially fatal lung disease. From chest x-rays, it is has not been established that silicosis can be distinguished from CWP. Another possible contributor to the high CWP prevalence is the high portion of small mines, fewer than 50 employees, found in the region. These small mines may lack the knowledge, resources, and resolve to adequately control dust.

The objectives of this project are to identify the types and effectiveness of the dust controls currently being used by mines in the SAR (with emphasis on small mines), develop dust controls targeted for the unique conditions found in these mines, and to provide educational materials to promote and facilitate implementation of these controls.

The project has been subdivided into five tasks to be carried out over a period of four years:

- Task 1 – Survey the conditions at the mines: Utilize Mine Safety and Health Administration (MSHA) inspector and mine operator compliance sampling data (e.g., average dust concentration, reduced dust standards, number of samples exceeding the dust standard) to identify mines of interest. In addition, RHCB personnel will periodically interact with personnel from DRDS in Morgantown to gather information of cases of rapidly progressing CWP for mines located within the SAR. The MSHA district offices will then be visited to gather data from dust/ventilation plans and inspector reports on selected mines. The types of controls and the level of controls will be established. Information such as type of equipment, ventilation quantities, water usage, and mining height (including rock cutting) will be gathered.

- Task 2 – Identify effective control technologies: Utilize compliance sampling data to identify six of the "cleanest" mines and six of the "dustiest" mines. Data from these mines will be compared to highlight the differences in the dust controls employed. Subsequent mine visits will be completed to document the effectiveness of current controls and to uncover good/poor practices which are not evident from inspection reports.

- Task 3 – Develop appropriate dust controls: Utilizing information from Task 2, develop dust controls targeted to reduce overexposures in these mines, many of which may be small mines working in low coal seam. Past dust control research has typically emphasized medium-to-high seams. Perform laboratory work at the Respiratory Hazards Control Branch full-scale dust and ventilation galleries to study interactions between water sprays, dust scrubbers, and face ventilation in low coal applications.

- Task 4 – Implement control technologies: Conduct field evaluation of new dust controls developed in the laboratory that have been targeted for these mines. This will involve the use of gravimetric samplers placed on equipment, operators, and in the intakes and returns to properly evaluate the effectiveness of the controls. Personal Data RAMS (PDR) will also be used to gather real-time dust concentrations. Several personal dust monitors (PDM) may be employed during these field evaluations to supplement the data collected with gravimetric samplers.

- Task 5 – Develop the appropriate training materials: Update the Guidelines for Dust Control in Small Underground Coal Mines which was published by the Bureau of Mines in 1987. The updated handbook will also be made available on the NIOSH website. Develop control technology training modules that are targeted for presentation at annual refresher training classes, which are required by MSHA for all miners.

OUTCOME: Successful completion of this research program will reduce the respirable dust exposure of workers in the SAR and will ultimately lead to reduction in lung disease in this high-risk region.

PERFORMANCE SITE(S) (organization, city, state)

1) NIOSH Pittsburgh Research Laboratory, Bruceton, PA

2) Mines throughout the southern Appalachian region, which includes eastern Kentucky, southern West Virginia, and western Virginia

3) MSHA – headquarters office in Arlington, VA and district offices

KEY PERSONNEL

NAME	ORGANIZATION	ROLE ON PROJECT
Douglas E. Pollock	NIOSH	Principal Investigator (Mechanical Engineer)
Gerrit Goodman	NIOSH	Co-investigator (Mining Engineer)
Timothy Beck	NIOSH	Co-investigator (Mining Engineer)
Randy Reed	NIOSH	Co-investigator (Mining Engineer)
Jerry Joy	NIOSH	Co-investigator (Industrial Hygienist)

BIOGRAPHICAL SKETCH:

NAME	POSITION TITLE		
Douglas E. Pollock, P.E.	Mechanical Engineer		
EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)			
INSTITUTION AND LOCATION	**DEGREE (If applicable)**	**YEAR(s)**	**FIELD OF STUDY**
University of Pittsburgh at Johnstown Johnstown, PA 15907	B.S.	1986	Mechanical Engineer

RESEARCH AND PROFESSIONAL EXPERIENCE:

Commonwealth of Pennsylvania, Licensed Professional Engineer PE-043822-E 1993
Association of Energy Engineers Certified Energy Manager 1999

1986 to 1987
Booz Allen & Hamilton Inc.

Security Clearance: Secret

Engineer/Consultant - Provided ship systems engineering support to the TRIDENT submarine acquisition program in the Naval Sea System Command (NAVSEA).

1987 to 1989
U.S. Army Depot System Command

Security Clearance: Secret

General Engineer - Provided engineering support to the Headquarters, U.S. Army Depot System Command (DESCOM) Facilities Engineering Branch. Participated in several Joint Chiefs of Staff (JCS) operations as the DESCOM facilities engineer. Acted as the DESCOM Energy Officer responsible for goal setting, reduction ideas, and energy monitoring of 16 Army depots located throughout the United States.

1989 to 1990
Letterkenny Army Depot
Operations and Maintenance Division

General Engineer - Provided engineering support to the Operations and Maintenance Division of Letterkenny Army Depot.

1990 to 2002
Pittsburgh Research Laboratory/ Administrative Service Branch/ Facilities Engineering

General Engineer - Provided facilities engineering support to the Pittsburgh Research Laboratory of the National Institute for Occupational Safety and Health.

2002 to Present
Pittsburgh Research Laboratory/ Respiratory Hazards Control Branch/ Dust Control

Mechanical Engineer - Provides research engineering support to the Dust Control Section of the Pittsburgh Research Laboratory's RHCB Branch. Responsible for project apparatus design, conducting research tests, and collection and analysis of data.

<u>Honors:</u>

Outstanding Performance: 2001, 2003
Excellent Performance: 1995, 2000, 2002, 2004

<u>Publications</u>:

Cecala, AB, JA Zimmer, JF Colinet, RJ Timko, GJ Chekan, and DE Pollock. Control Technology Using Ventilation to Reduce Respirable Dust Exposures at U.S. Metal/Nonmetal Mining Operations. To be published at 8th International Mine Ventilation 2005 Congress. Brisbane, Queensland, Australia, July 2005.

Cecala, AB, AD O'Brien, DE Pollock, JA Zimmer, JL Howell, and LJ McWilliams. Reducing Respirable Dust Exposure of Workers Using An Improved Clothes Cleaning Process. Journal of Occupational and Environmental Hygiene. Journal review – to be published 2005. (Peer Reviewed)

Organiscak, JA, DE Pollock. Development of a Lower Pressure Water-Powered Spot Scrubber for Mining Applications. 2005 SME Annual Meeting and Exhibit. Salt Lake City, Utah, March , 2005

Pollock, DE, AB Cecala, AD O'Brien, JA Zimmer, JL Howell. A New Method to Clean Dust-Soiled Work Clothes. Rock Products, March, 2005.

Goodman, GVR, DE Pollock. Use of a Directional Spray System Design to Control Respirable Dust and Face Gas Concentrations Around a Continuous Mining Machine. Journal of Occupational and Environmental Hygiene, December, 2004, pp.806-815.

Goodman, GVR, DE Pollock, and TW Beck. A Comparison of a Directional Spray System and a Flooded-Bed Scrubber for Controlling Respirable Dust Exposures and Face Gas Concentrations. Proceedings of the Tenth US/North American Mine Ventilation Symposium, Anchorage, Alaska, May, 2004. pp. 241-248.

BIOGRAPHICAL SKETCH:

NAME	POSITION TITLE		
Gerrit V.R. Goodman	Mining Engineer		
EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)			
INSTITUTION AND LOCATION	**DEGREE (If applicable)**	**YEAR(s)**	**FIELD OF STUDY**
Penn State University	B.S.	1979	Mining Engineering
Virginia Tech	M.S.	1980	Mining Engineering
Virginia Tech	Ph.D.	1987	Mining Engineering

RESEARCH AND PROFESSIONAL EXPERIENCE:

Employment

Consolidation Coal Company	6/75-8/77	Cooperative employment working in underground coal mines during summers and falls
Virginia Tech	3/79-9/80	Graduate teaching assistant (classroom and laboratory teaching)
Consolidation Coal Company	9/80-9/82	Assistant mine engineer in charge of production and reclamation planning at two surface mining operations
Virginia Tech	10/82-5/87	Graduate teaching assistant (classroom and laboratory teaching)
U.S. Bureau of Mines/NIOSH, Respiratory Hazards Control Branch	5/87-present	Mining engineer involved in research to improve both face ventilation and dust control for continuous mining operations

Honors

1999 Stefanko Award – awarded by the Coal Division/SME for the paper "Variations in Dust Levels with Continuous Miner Position" which had been presented at the 1998 SME annual meeting.

Outstanding Performance: 1988, 2000, 2002, 2003, 2004

Excellent Performance: 1989, 1990, 1991, 1992, 1995, 1999, 2001

Publications

Goodman GVR and Pollock DE [2004]. Use of a Directional Spray System Design to Control Respirable Dust and Face Gas Concentrations Around a Continuous Mining Machine. J. Occup. Environmental Hygiene, 1(12):806-815.

Goodman GVR, Pollock DE, Beck TW [2004]. A Comparison of a Directional Spray System and a Flooded-bed Scrubber for Controlling Respirable Dust Exposures and Face Gas Concentrations. Proceedings, 10th US/North American Mine Ventilation Symp., Anchorage, AK, May.

Kissell FN, Goodman GVR [2003]. Continuous Miner and Roof Bolter Dust Control. In Handbook for Dust Control in Mining, Information Circular, No. 9465, DHHS (NIOSH) Publication No. 2003-147.

Goodman GVR, Organiscak JA [2003]. Assessment of Respirable Quartz Dust Exposures at Roof Bolters in Underground Coal Mining. Journal, South Afr. Mine Vent. Society, 56(2):50-54.

Goodman GVR, Organiscak [2002]. Evaluation of Methods for Controlling Silica Dust Exposures on Roof Bolters. Transactions, Society for Mining, Metallurgy, and Exploration, 312:133-137.

Goodman GVR, Listak JM, Organiscak JA [2001]. An Assessment of Occupational Silica Exposures on Continuous Mining Operations. Transactions, Society for Mining, Metallurgy, and Exploration, 310:63-68.

Goodman GVR, Taylor CD, Colinet JF, Thimons ED [2001]. Research by NIOSH for Controlling Respirable Dust and Methane Gas on Continuous Miner Faces. Proceedings, 7th International Mine Ventilation Congress, Krakow, Poland.

Goodman GVR, Organiscak JA [2001]. Laboratory Evaluation of a Canopy Air Curtain for Controlling Occupational Exposures of Roof Bolters. Proceedings, 7th International Mine Ventilation Congress, Krakow, Poland.

BIOGRAPHICAL SKETCH:

<table>
<tr><th>NAME</th><th colspan="3">POSITION TITLE</th></tr>
<tr><td>Timothy W. Beck</td><td colspan="3">General Engineer</td></tr>
<tr><th colspan="4">EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)</th></tr>
<tr><th>INSTITUTION AND LOCATION</th><th>DEGREE (If applicable)</th><th>YEAR(s)</th><th>FIELD OF STUDY</th></tr>
<tr><td>University of Missouri - Rolla</td><td>BS</td><td>2000</td><td>Mining Engineering</td></tr>
</table>

RESEARCH AND PROFESSIONAL EXPERIENCE:

2000-2002: Mining Engineer, TXU Mining Company, Big Brown Mine, Fairfield, TX.

As part of TXU training program, rotated through different departments and worked as an Applications Engineer and Operations Engineer. In these positions, worked on multiple projects related to improving operations at the mine. In last year of employment, worked as an Operations Foreman and supervised a 30-person production crew.

2003-present: General Engineer, NIOSH-PRL, Pittsburgh, PA.

Conducting laboratory and mine site testing to evaluate dust control technologies for use in underground coal mines.

<u>Publications</u>

Goodman GVR, Pollock DE, Beck TW [2004]. “A comparison of a directional spray system and a flooded-bed scrubber for controlling respirable dust exposures and face gas concentrations.” Proceedings, 10th US/North American Mine Vent. Symp., May 17-19, Anchorage, AK, pp. 241-248.

BIOGRAPHICAL SKETCH:

NAME	POSITION TITLE		
Wm. Randolph Reed	Mining Engineer		
EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)			
INSTITUTION AND LOCATION	**DEGREE (If applicable)**	**YEAR(s)**	**FIELD OF STUDY**
University of Missouri-Rolla Rolla, Missouri	B.S.	1988	Mining Engineering
Wingate University Wingate, North Carolina	M.B.A.	1998	Business
Virginia Polytechnic Institute & State Univ. Blacksburg, Virginia	Ph.D.	2003	Mining Engineering

RESEARCH AND PROFESSIONAL EXPERIENCE:

<u>Employment</u>

1988-1990	Rand Mining Company	- Mining Engineer
1990-1997	Costain Minerals, Ltd.	- Sr. Project /Mine Engineer
1998	Concord Engineering & Surveying	- Project Manager
1999-2000	Virginia Tech	- Research Assist./ Instructor
2003- present	CDC/NIOSH/PRL/RHCB	- Mining Engineer

<u>Registered Professional Engineer</u>

South Carolina (1994)	-#15904
North Carolina (1994)	-#20384
Georgia (1995)	-#21838
Pennsylvania (1997)	-#053201
Virginia (1998)	-#33289

<u>Recent Publications</u>

Reed, Wm. R., and Organiscak, J.A.; "The Evaluation of Dust Exposure to Truck Drivers Following the Lead Haul Truck." <u>2005 SME Annual Meeting, Salt Lake City, UT, Feb 28 - Mar 2, 2005, SME Preprint #05-10</u>, (Littleton, CO: SME, 2005).

Reed, Wm. R. and Westman, E.C.; "A Visual Basic Model for Predicting the Dispersion of Dust from a Haul Truck." International Journal of Surface Mining, Reclamation, and Environment. (Accepted for publication 2005).

Organiscak, J.A.; Reed, Wm. R.; Page, S.J.; and Cecala, A.B.; "NIOSH Studies Show Practical Aspects of Controlling Surface Mine Dust." Longwall USA, June 7-9, 2005. (Accepted for Publication 2005).

Reed, Wm. R.; Organiscak, J.A.; and Page, S.; "New Approach Controls Dust at the Dust Collector Dump Point, NIOSH Finds a Simple, Cost-Effective Solution for Reducing Dust for Blasthole Drills." Coal Age, (June 2004) 20-22.

Reed, Wm. R.; Organiscak, J.A.; and Page, S.; "New Approach Controls Dust at the Dust Collector Dump Point, NIOSH Finds a Simple, Cost-Effective Solution for Reducing Dust for Blasthole Drills." Engineering & Mining Journal, (July 2004) 29-31.

Reed, Wm. R.; "Performance Evaluation of a Dust Dispersion Model for Haul Trucks." SME Transactions, Vol. 316, (2004) 163-170.

Organiscak, J.A. and Reed, W.R.; "Characteristics of Fugitive Dust Generated from Unpaved Mine Haulage Roads." International Journal of Surface Mining, Reclamation, and Environment, Vol. 18, No. 4 (2004), 236-252.

Reed, W. R.; "Significant Dust Dispersion Models for Mining Operations." NIOSH Information Circular. (Submitted for publication Sept. 2004).

Reed, Wm. R.; Westman, E.C.; and Haycocks, C.; "The Introduction of a Dynamic Component to the ISC3 Model in Predicting Dust Emissions from Surface Mining Operations." Application of Computers and Operations Research in the Mineral Industry, Proceedings of the 30th International Symposium. Ed. Bandopadhyay, S.; (Littleton, CO: Society for Mining, Metallurgy, and Exploration, Inc. 2002) 659-667.

BIOGRAPHICAL SKETCH:

NAME	**POSITION TITLE**		
Gerald J. Joy	Industrial Hygienist		
EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)			
INSTITUTION AND LOCATION	**DEGREE (If applicable)**	**YEAR(s)**	**FIELD OF STUDY**
West Virginia University, Morgantown, WV	B.A.	1978	Chemistry
University of Pittsburgh, Pittsburgh, PA	M.S.	1979	Chemistry
University of Pittsburgh, Pittsburgh, PA	M.S. Hyg.	1982	Industrial Hygiene

RESEARCH AND PROFESSIONAL EXPERIENCE:

1983-1985 Senior Industrial Hygienist, New York State Department of Labor
1985-1987 Health and Safety Coordinator, IT Corporation
1987-1989 Emergency Response Technical Coordinator, IT Corporation
1989-1990 Health and Safety Manager, IT Corporation
1990-1994 Health and Safety Manager, ICF Kaiser Engineers, Inc.
1994-1999 Director, Industrial Hygiene, ICF Kaiser Engineers, Inc.
1999-2002 Health and Safety Director, Shaw Environmental & Infrastructure, Inc.
2003- now Industrial Hygienist, NIOSH/PRL/RHCB

1988 Certified Industrial Hygienist
1990 Certified Safety Professional

<u>Publications</u>

Joy, GJ and Middendorf P., Trends in Noise Exposure & Hearing Conservation in U.S. Coal Mines, Journal of Occupational and Environmental Hygiene., (2005)

Research Proposal, Personnel Plan, and Budget

RESOURCES

FACILITIES:

Laboratory: (Provide room numbers where the work will be performed)

PRL Building 151 full-scale continuous mining machine test gallery: continuous mining machine equipped with both flooded bed dust scrubber and spray fan systems (Figure 1). Sensors installed to give real-time outputs of water spray pressure and flow rate. Gallery roof can be adjusted to simulate different mining heights. The ventilation system in the test gallery is designed to allow a large range of air volume flow adjustment along with various curtain setback configurations.

Figure 1. Continuous Miner Dust Gallery

Field: (Identify workplaces or other sites to be used.)

Various small mines located throughout the southern Appalachian region. Coordination and assistance from MSHA field districts will be critical for this project's success. MSHA field district offices will be visited to view the mine inspector reports and compliance data in order to target small mines for future field surveys.

Animal: (Provide room numbers where the work will be performed. Provide requests for special care and handling of the animals or for special equipment needed in the animal facilities.)

N/A

Other:

N/A

Major equipment: List the most important equipment items already available for this project, noting the location and pertinent capabilities of each.

PRL Building 151 full scale continuous miner test facility, Real-time aerosol monitors (RAM) with data logging capabilities, Building 144 environmentally controlled weighing laboratory for analysis of gravimetric filters.

The Research Plan:

a) Specific Aims

The intent of this project is to investigate the high prevalence of CWP in the southern Appalachian region and to develop dust control technologies and methods to reduce elevated exposures. The project will address these issues by completing the following:

- Determine the possible causes of the high CWP in the hotspot areas by identifying significant characteristics of the mines in these areas. Investigate compliance data and inspector reports of MSHA district offices in these areas in order to determine similarities/differences in control practices, equipment types, operating conditions, etc.

- Perform on-site dust surveys to quantify dust levels, control technologies utilized, and operating practices. Identify six of the cleanest and six of the dustiest mines of the SAR and contrast their methods of dust control. Define successful controls and areas of additional need.

- Develop new dust control technology/methods for application in the targeted mines, which will likely consist of small and/or low seam mines. Optimize existing controls and/or develop new control technologies through laboratory testing and field evaluation.

- Develop an aggressive technology transfer effort to reach target mines by: completing an update of the Dust Control for Small Mines handbook, presenting research results in peer-reviewed journals, trade journals, and at mining conferences, holding workshops in the SAR, and developing a training module that can be incorporated into annual refresher training.

b) Background and Significance

If the national effort to reduce coal workers' pneumoconiosis (CWP) is to be truly comprehensive, it is necessary to monitor the progress that is being made to eradicate it. This monitoring has been conducted through the National Coal Workers' X-ray Surveillance Program, which is administered by NIOSH. In this program, underground coal miners are offered a free chest radiograph at first employment and every 5 years thereafter while employed. These radiographs are then used to determine whether the miner is suffering from coal workers' pneumoconiosis (CWP), and successive radiographs may be used to chart the progress of the disease.

Data from the latest round of x-rays in this surveillance program was combined with x-rays from the Miners Choice Program [CDC, 2003], a special program sponsored by MSHA. Results showed that the prevalence of CWP among miners participating in these programs continues to decline, but that new cases are occurring among miners who have worked exclusively under current dust exposure limits. There were two other significant findings in this report that are especially relevant to this proposal.

The first finding was a wide variation in CWP prevalence from state-to-state. This state-to-state variation may be seen by dividing the major coal mining states into highest and lowest- prevalence groups (Table 1):

Table 1. Major coal-producing states, divided by prevalence of CWP

State	Prevalence of CWP[1]
Maryland	9.60%
Virginia	8.60%
West Virginia	7.60%
Tennessee	4.90%
Kentucky	3.50%
Pennsylvania	1.80%
Ohio	1.70%
Colorado	1.50%
Illinois	1.10%
Utah	0.50%

1[1] Based upon small opacity profusion greater than or equal to ILO category 1/0.

The second finding was an equally large difference between miners who work at small mines and those who work at large mines. Across the U.S., in small mines with less than 50 employees, the CWP prevalence was 5.6%, and in large mines with 50 or more employees, the prevalence was 2.0%. These state-to-state variations and small-to-large mine variations are not entirely separate issues because the states with higher CWP appear to have a higher proportion of small mines.

These two findings are critically important to the development of new control technology and the thrust of technology transfer. If the prevalence of CWP is to be reduced below current levels, the most success will be found by targeting the unique mining conditions leading to the higher prevalence values. Simply put, to succeed we must go to where most of the black lung is.

c) Preliminary Studies/Progress Report.

In collecting additional prevalence information for this proposal, we have also found that the X-ray surveillance program data shows, in addition to state-to-state differences, large county-to-county differences within some states. For example, CWP prevalence is much higher in eastern Kentucky than in western Kentucky, and much higher in southern West Virginia than in northern West Virginia. Others in NIOSH and MSHA have come to similar conclusions. For example, a high proportion of miners experiencing a rapid progression of CWP were found in the so-called Southern Appalachian Region (SAR) a geographic cluster consisting of the southern Appalachian counties of eastern Kentucky, southern West Virginia, and western Virginia [Antao, 2005]. These counties also had high prevalence rates, with the highest prevalence counties shown in Table 2. By comparison, the average prevalence rate across the U.S. is 3.2%.

Table 2. CWP geographic cluster [Antao, 2005]

County, State	Prevalence of CWP[1]	No. of miners evaluated[2]
Randolph, WV	0.176	8
Grant, WV	0.143	7
Raleigh, WV	0.109	51
Dickenson, VA	0.103	31
Tazewell, VA	0.099	26
Buchanan, VA	0.086	122
Preston, WV	0.08	16
Pike, KY	0.068	73
Wise, VA	0.06	63
Floyd, KY	0.059	6
Upshur, WV	0.053	13
Martin, KY	0.05	10

[1] Only prevalence data is shown here. Miners with small opacity profusion greater than or equal to ILO category 1/0 divided by the estimated average number of miners employed by county.
[2] In some counties the prevalence values might be questioned because of the small number of miners evaluated. However, the overall trend is unmistakable.

The notion that there is a significant clustering of CWP in the U.S. is not an entirely new one. The Work-Related Lung Disease Surveillance Report [NIOSH, 2002] lists U.S. counties with the highest mortality rates for CWP deaths between 1985 and 1999. Two high rank coal regions stand out. Counties in the southern Appalachian region (23%) and the Pennsylvania anthracite region (31%) account for over half of all fatalities reported nationwide. Anthracite mining has seen a significant decline and should not result in the degree of CWP that has been observed in the past, leaving the SAR as the most problematic region.

Possible causes of CWP variability. If CWP is to be reduced through control technology research, through technology transfer, and through implementation of these technologies, then it is important to have knowledge of the circumstances that lead to geographic clustering. Three possible causes of CWP clustering stand out: first are geographic differences in the rank of coal being mined; second are geographic differences in the amount of silica associated with the coal being mined; and third is the difficulty associated with application of dust controls in small mines. We will discuss each of these in turn.

Effect of coal rank The rank of a coal seam is a measure of the degree to which the coalification process (the transition from plant matter to coal with progressively higher carbon content) has proceeded, with higher rank coals exhibiting higher carbon content. It has been known for many years that miners who work in seams of higher rank coal are more susceptible to CWP. This relationship has been found to exist in the United States [McBride et al., 1963][Morgan, 1968][Dessauer, 1972], Great Britain [Jacobsen et al., 1971][Bennett et al., 1979], and Germany [Reisner and Robock, 1977].

Elevated rank can be used to explain part of the geographic clustering. A rank contour map of West Virginia,[1] shown as Figure 2, indicates higher rank coals, also known as low- medium-volatile bituminous coals in the counties of southern West Virginia, which includes the counties shown in Table 2.

[1] Source: West Virginia Geological Survey (www.wvgs.wvnet.edu/www/datastat/te/Photos/Rankmap.gif)

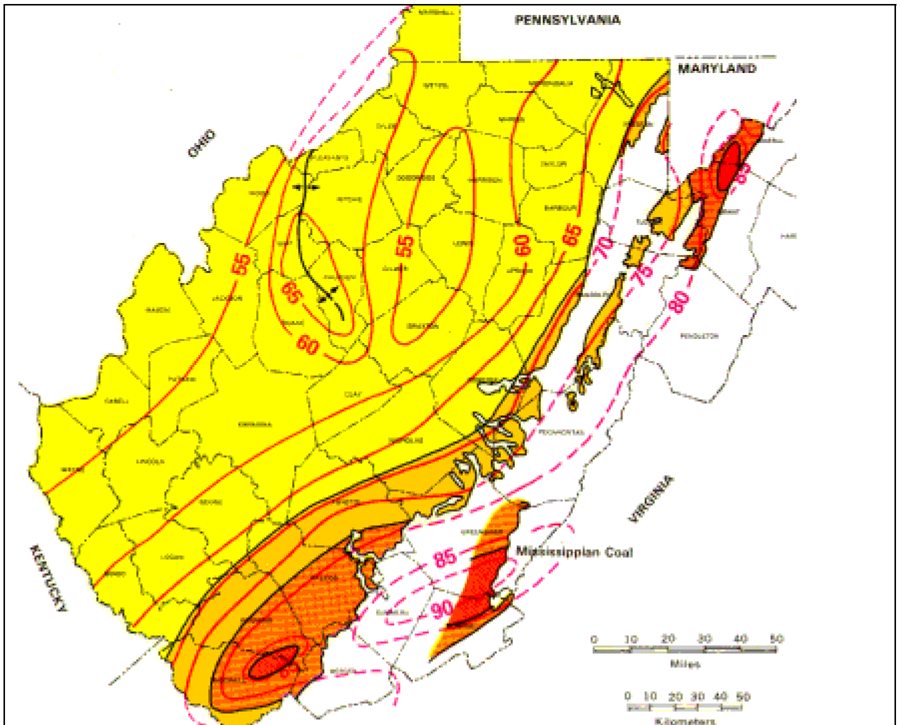

Figure 2. Rank Contour Map of West Virginia. Values shown represent percentage of fixed carbon (dry, ash-free)

Coal production from the state of Virginia originates in the counties in the western part of the state (Figure 3). These counties are adjacent to southern West Virginia, and the rank of the coals is similar.[2]

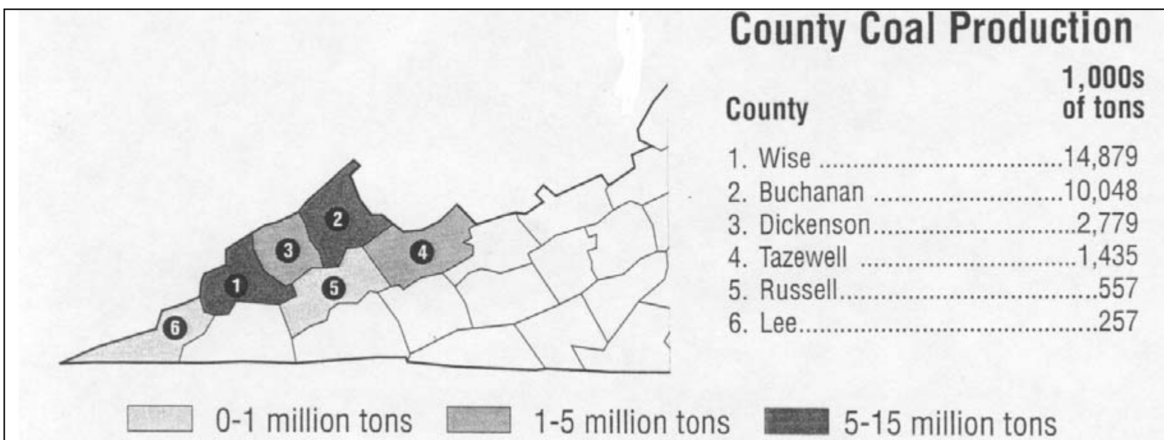

Figure 3. Coal producing counties of Western Virginia

For Kentucky, however, the coals in the eastern counties adjacent to southern West Virginia have a slightly lower rank than the coals of southern West Virginia. For

[2] Source: Virginia Dept. of Mines, Minerals, and Energy (www.energy.vt.edu/vept/coal/coal_rank.asp)

example, coals in the Big Sandy district of eastern Kentucky (the eastern tip of Figure 4) have an average fixed carbon value of 62% [Keystone, 2004][3], which may in part explain the lower CWP prevalence for Kentucky counties shown in Table 2.

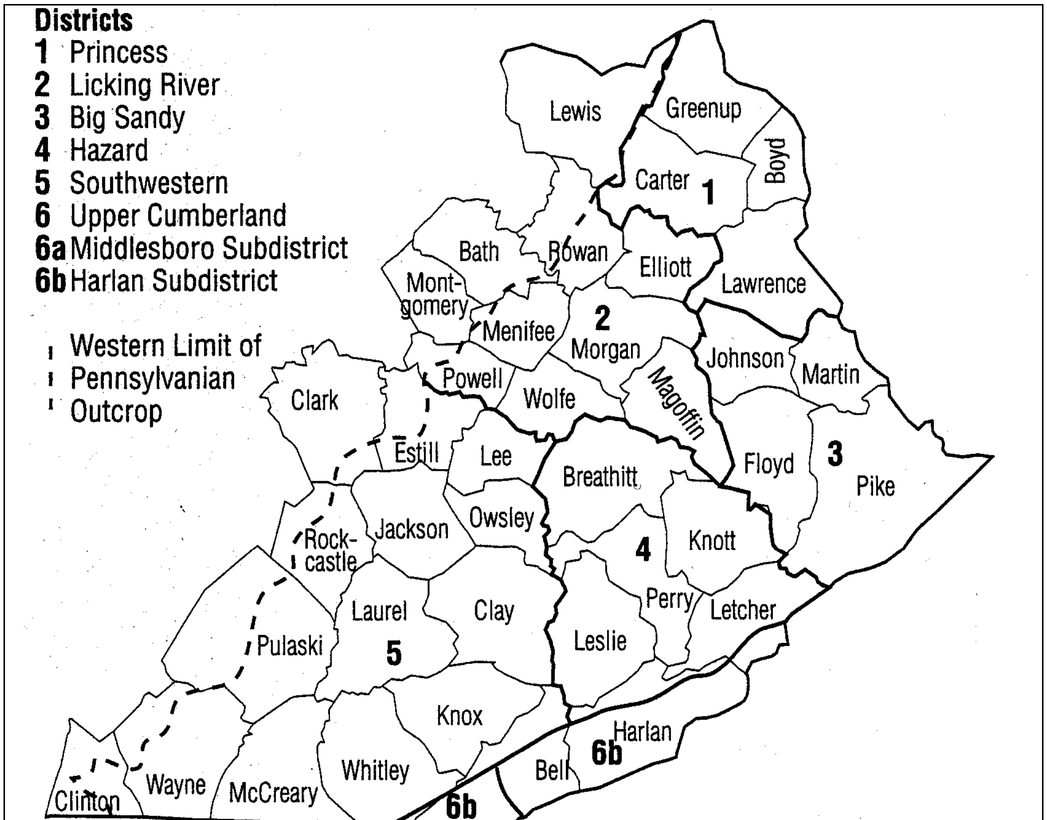

Figure 4. Map of the Eastern Kentucky coalfield showing its six districts.

While this proposal discusses coal rank as a possible contributor to CWP hotspots, RHCB does not intend to include this item for further investigation in this proposal. RHCB will focus on the mines in the SAR from a dust control and operations standpoint. However, RHCB personnel have had discussions with personnel from NIOSH's Division of Respiratory Disease Studies (DRDS) concerning the CWP hotspot problem. DRDS has expressed an interest in working jointly with RHCB and will focus upon the coal characteristics and epidemiological aspects of the CWP hotspot issue. Consequently, RHCB personnel plan to cooperate with DRDS in collecting and evaluating information concerning the relationship(s) between CWP and coal characteristics in the SAR.

Silicosis and the reduced standard Silicosis is an irreversible and progressive lung deterioration arising from the inhalation of respirable crystalline silica. This disease may be chronic, complicated, accelerated, or acute depending upon the length and intensity of the exposure. Miners with silicosis have an increased risk of lung cancer and other pulmonary disorders such as tuberculosis. Silica exposure may be a factor in the rapid development of progressive massive fibrosis (PMF). The Federal Coal Mine Health and

[3] Keystone gives rank values for raw coal. The authors corrected these values to put them on a dry, ash-free basis in order to facilitate a direct comparison with Figure 3.

Safety Act limits the amount of worker exposure to respirable silica dust by reducing the dust standard to 10 ÷ % silica when silica contents exceed 5% by weight. Compliance with a reduced standard maintains silica dust levels at or below 100ug/m^3.

Effect of silica   As a cause of coal workers' pneumoconiosis, the role of silica is usually seen as minor when compared to the mass of respirable dust that has been inhaled. For example, Hurley et al. [1982] conducted radiological assessments of 2600 British coal miners and reported that there was no evidence that the silica concentrations experienced (average 5% of mixed dust) affected the probability of developing coal workers' simple pneumoconiosis.

Nevertheless, a case-control study of men with unusually rapid progression of pneumoconiosis [Jacobsen and MacLaren, 1982] suggested that higher silica exposures were associated with a more aggressive form of the disease, and perhaps influenced the risks of developing PMF. More recently, Buchanan et al. [2003] have re-examined data collected during the Pneumoconiosis Field Research (PFR) program at one Scottish colliery where adverse geological conditions in the last decade before its closure in 1981 meant that sandstone roof and floor was machine cut along with the coal seam. The miners were exposed to higher silica exposures and subsequently showed more rapid progression of silicotic abnormalities on their chest X-rays than was typical of the others.

Statistical analysis for this mine showed that the risk of contracting silicosis was more closely related to the sum of the times spent in occupational groupings weighted by the square of silica concentration than the usually accepted model where risks from coal mine dust are simply related to cumulative exposure. This new analysis predicted that only twelve months exposure to 2 mg/m^3 silica was associated with a 73% risk of category 2/1 or greater silicosis. However, for lower silica concentrations in other mines, conventional cumulative exposures did appear to describe risks adequately (in that silica is a relatively unimportant determinant of risk from coal mine dust).

The counties of the SAR where Antao noted a rapid progression of CWP are also noted for their high silica levels, according to MSHA information regarding mines on reduced dust standards because of high silica levels. For example, in 2004, 35% of the 527 working sections (MMU) in the three MSHA districts comprising the SAR were on reduced dust standards due to more than 5% silica in the coal dust. In the other seven MSHA districts comprising the rest of the United States, only 6% of 324 working sections were on reduced dust standards. Thus, 90% of coal mine working sections in the United States on reduced standards are located in the SAR [Lindahl, 2005].

It is also instructive to examine the SAR proportion of working sections with silica levels exceeding 10%, equivalent to a reduced standard of 1.0 mg/m^3 or less. Across the United States, there are 59 working sections in this category. Of these, 45, or 76%, are in the SAR.

Small mines   The SAR is a mountainous region with erosional and folded features that provide significant relief. More than other parts of the U.S., it contains deeply incised stream valleys where stream cutting has exposed rock layers and coal seams at outcrop. These seams are mainly of Pennsylvanian Era, and are interbedded with siliclastic rock layers. Figure 5 shows a generalized geologic north-south cross section through the Eastern Kentucky Coalfield. It illustrates the great extent to which stream cutting has exposed outcrops of Pennsylvanian Era, shown as Pbu coal seams.

Coal outcrops facilitate the development of small drift mines that require less investment because no vertical shafts are needed. Small, undercapitalized companies can open a mine, and the SAR region, particularly in Kentucky, is known for its numerous small mines. For example, [DOE, 2003] data for the Pikeville KY zip codes of 41501 and 41502 indicates 59 small mines employing 1265 individuals and 6 large mines employing 384 individuals.

A high proportion of the small mines are in thin seams (so-called “low coal”) where the siliclastic roof rock must be cut to gain adequate height for haulage equipment such as conveyor belts. Such mines are expected to have higher silica levels.

Safety conditions have been more problematic in small mines. Mines employing fewer than 50 people are responsible for a disproportionate share of fatal accidents. For the last several years, the fatal injury incidence rate at small mines has been more than double the rate for larger mines [Lauriski, 2003]. The operators of small mines often lack such resources as full-time safety directors, which larger companies can afford.

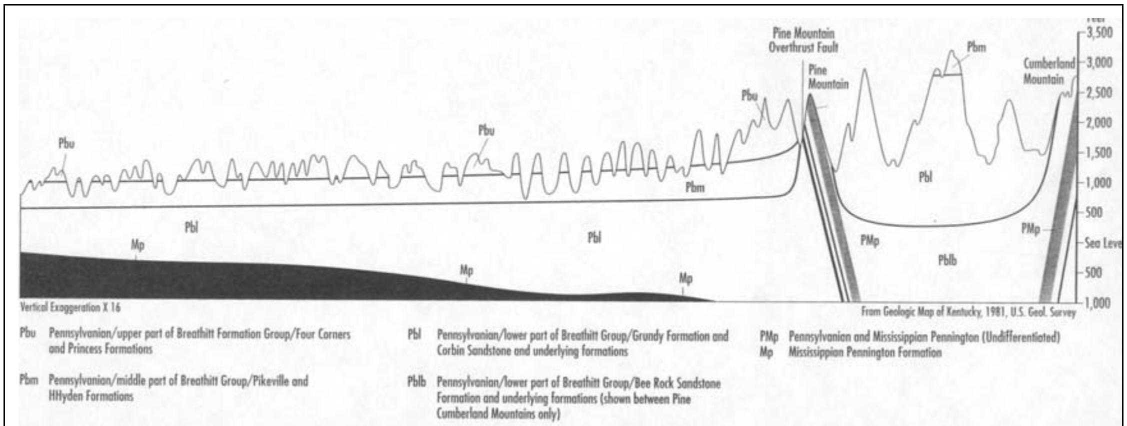

Figure 5. Generalized north-south cross section through the Eastern Kentucky Coalfield.

<u>Impact of research and technology transfer:</u> Given the elevated levels of CWP found in the SAR, control technology research and technology transfer of dust control information has the potential to have a highly positive impact on reducing the incidence of CWP in mines in the SAR. It is likely that all three factors – rank, silica, and mine size – will have some importance because they are all intertwined to some degree. The data collection and mine surveys proposed in the next section will be able to establish:

- the extent to which operators in the SAR are knowledgeable about dust controls
- whether SAR dust controls are up to national standards

- the degree to which extra roof cutting in low coal raises the silica level
- whether available control technology is meeting the unique needs of operators of low coal mines
- a contrast in the dust control practices of clean mines versus dusty mines – what are the clean mines doing that is different from the dusty mines. This technique has proven successful in past longwall mining research [Taylor et al, 1982] and [Jankowski et al, 1983].

d) Research Design and Methods

The ultimate goal of this research project is the development of improved dust control techniques and methods for mines located throughout the southern Appalachian region (SAR) thereby reducing worker exposure to elevated respirable dust levels. Findings may well also be applicable in varying degrees to other coal mining areas as well.

A summary of the work to be done is the following. The project will commence with an analysis of the MSHA compliance dust sampling data located in the TERA data base in order to do a preliminary evaluation of mines located in the SAR. Mines consistently maintaining compliance and mines exhibiting difficulty with maintaining compliance will be identified. Visits to the MSHA district offices will then be scheduled to examine dust control and ventilation plans and inspector reports. Discussions with MSHA health specialists will also provide information on control technologies and their use. Six of the cleanest mines and six of the dustiest mines will be identified. Mining conditions (rock thickness and coal thickness), equipment types, ventilation techniques and quantities, water usage and mining height will be compared and categorized in order to determine any relationships with measured dust levels. The data and observations will be compared to determine effective/ineffective methods for dust control. This approach was utilized in past longwall mining research with very favorable results [Taylor et al, 1982] and [Jankowski et al, 1983]. Subsequent field visits will be scheduled to each of these mines to conduct dust surveys during operation and to observe and possibly uncover conditions not obvious from the MSHA inspection reports. Dust controls in place will be evaluated in terms of their efficiencies in reducing worker exposures. Laboratory testing will then be conducted to improve dust controls including parameters such as air velocity, air flow quantity, water pressure, etc., while simulating mining conditions observed during the underground surveys. Return field visits will then be made to a number of the mines to implement and demonstrate the optimum dust controls from the laboratory testing in real world conditions. Technology transfer and training materials will be prepared to disseminate findings to the mining industry and regulatory personnel.

The following is a detailed description of the specific tasks to be completed:

1. <u>MSHA district office visits:</u> NIOSH will evaluate the compliance sampling data base to identify mines of particular interest based upon compliance history, level of silica, and mining conditions. MSHA field offices will be then be visited and

data gathered on approved dust-control plans for each of the selected underground small mines. MSHA dust samples will be utilized as well as operator samples. Current and historic samples will be examined. The current samples will be useful to relate measured dust levels during compliance sampling to existing control technologies and operating procedures. Current overexposures must be addressed in an effort to prevent the development of future cases of CWP. The investigators will also review the mine inspector reports and discuss operating practices for these mines with MSHA personnel. The production rate, mine equipment types, ventilation systems (both section and face), water pressures, spray systems and other unique characteristics to the mine will be noted. The inspector reports and compliance data will allow determination of the six dustiest and the six cleanest mines in the SAR. The data from these mines will then be compared in order to highlight the differences and identify factors that influence dust levels. Data and findings from the district office visits will routinely be shared with colleagues at DRDS. DRDS has data related to rapid progression of CWP for a number of mines in the SAR. This data will be used in the identification of the clean and dusty mines by cross referencing it with the compliance sampling data gathered by RHCB researchers Meetings with DRDS will be scheduled to discuss the selection of the mines for dust surveys.

2. <u>Mine surveys:</u> Mine surveys will be scheduled at the 12 mines selected to investigate and confirm findings from the district reports as well as to uncover conditions not obvious in the reports. The cleanest mine sites will be visited to observe their operations and to learn what they are doing correctly. Surveys may target the continuous miner, roof bolter, or both depending on the findings from the MSHA district reports. Each survey will typically consist of three to four consecutive days of testing and observation during production. Time studies will be conducted to track continuous miner cuts, shuttle car and roof bolter locations, and various other operations which may influence dust exposure readings. Curtain setback and configuration will be noted for each cut. Face ventilation measurements will be taken with a vane anemometer at the beginning of all cuts. Thermo MIE Personal Data RAMs will be utilized to record dust concentrations during the surveys. The PDR is a real-time aerosol monitor with logging capability. A typical sampling package will consist of a PDR and two MSA Elf sampling pumps (calibrated to 2 liters per minute) with pre-weighed 37-mm MSA filters and 10-mm nylon cyclones. Prior to each cut, the sampling packages are set in the intake and return and on or around the targeted machine(s). The sampling pumps are run for the duration of the cut or operation of the machine and placed on hold during the move to the next cut. The PDR monitors are left in logging mode since they have real-time capability. This procedure enables the researcher to analyze dust generation on a cut by cut basis. The PDR enables us to observe a real-time dust level reading at the instrument location which can be evaluated by using our time study notes. We are able to track what the machine/individual was doing during the point in time of high dust. The PDR provides a relative measure of dust levels and we use the two gravimetric samplers on the sampling rack to calculate a correction factor that is applied to the

PDR measurements. The MSA filters will be post weighed for dust concentration at PRL and then sent out to an independent laboratory for silica analysis. A personal dust monitor (PDM) will be placed on the miner and/or bolter operators to provide real-time tracking of their dust exposure throughout the shift. Various maintenance tasks such as bit replacement, bolter dust box cleaning, and spray maintenance will be observed and noted. Water spray types will be noted, water quantity will be measured, and water spray pressures will be measured at the spray nozzle.

These initial mine surveys will provide baseline information regarding relative effectiveness of dust controls currently in use and identify areas of additional need.

3. <u>Evaluation of Dust Control Measures – Laboratory Evaluations:</u> The continuous miner dust gallery will be utilized for this portion of the project to both optimize controls currently employed in the mines and to develop new and novel control approaches. By utilizing this unique laboratory set-up, test conditions are repeatable, easily verified and statistically sound. Laboratory testing will likely require that low coal operating conditions be simulated. The gallery is equipped with an adjustable roof which can be lowered to desired test conditions. To simulate the dust generated during mining operation, Keystone Mineral Black will be injected at the face at the cutting drum of the miner by using compressed air and a vibratory screw feeder. The rotation of the cutting drum will mix the dust with air ventilating the face. Dust feed into the gallery area will be adjusted by monitoring the concentration in the return and adjusting the feed rate to match levels encountered in the field. In addition to gravimetric samplers, real-time dust concentrations will be monitored at the left and right sides of the miner, the operator position, the standard and off-standard shuttle car positions, and in the return with MIE real-time aerosol monitors (RAM). The study will consist of simulation of the conditions encountered during the field surveys while varying such elements as curtain set-back distance, water spray pressure, spray locations, ventilation air flow, and scrubber or spray fan modifications. A matrix of tests will be developed to properly analyze the impact of the test variables. Improvements in dust control will be shown by the reduced dust concentration levels at the various monitoring points. In addition, new or novel control technologies, such as redirected scrubber exhaust, directional spray system designs, or redesigned scrubber applications, will be evaluated in the gallery in an effort to advance dust control technology for these mining operations.

4. <u>Evaluation of Dust Control Measures – Field Evaluations:</u> After new or improved control methods/equipment modifications have been tested at the NIOSH PRL continuous miner dust gallery, they will be applied at a number of SAR mine sites. A second round of dust surveys, identical to the original surveys, will be completed to evaluate reductions in respirable coal and silica dust levels resulting from the new control technologies. As with the initial field studies, it is critical to have the cooperation from the small mines as well as the MSHA district offices

for the success of this portion of the project. These control technology evaluations will be conducted similar to the initial field studies and consist of time studies, PDR measurements, and gravimetric dust sampling of the intake, return, and areas around the equipment. The PDM will again be utilized to gain a real-time dust exposure picture of the operator throughout the shift. Three to four consecutive days of testing will be conducted for each field evaluation. Data from the field evaluations will be analyzed to note any reductions in face area dust concentrations and the personal exposure of the operator. Detailed field reports will be written to present the findings, and a copy will be sent to each mine to provide guidance for reducing the dust exposure of their workers.

5. Publications, Presentations and Training Material Development: The findings of this project will be published in peer reviewed articles, trade publications, technology newsletters directed to the mining personnel, as well as presentations at SME and workshops which will be developed for the small mine operators. The Guidelines for Dust Control in Small Underground Coal Mines handbook will be updated to reflect the findings of this project. The updated handbook will be available in both hard copy and electronic format on the World Wide Web. Efforts will be undertaken to work with our training personnel to optimize ways to transfer the findings of this research to the mines in the SAR. Coordination with both NIOSH and MSHA training personnel will be utilized to develop and include a module for small mine dust control which would be presented during MSHA's annual refresher training courses.

Project Timeline:

CY 2005
Q4- Visit MSHA Arlington Office. Meeting to discuss project approach and district office visits.

CY 2006
Q1- MSHA District 4, Mt. Hope, WV office visit
Q2- MSHA District 5, Norton, VA office visit
Q3- MSHA District 6, Pikeville, KY and District 7, Barbourville, KY office visits
Q4- Dust survey at selected mine in MSHA District 4

CY 2007
Q1- Dust survey at selected mine in MSHA District 4, Attend conference
Q2- Dust survey at selected mines in MSHA District 5 and District 6, Laboratory testing
Q3- Dust surveys at selected mines in MSHA District 6 and District 7, Laboratory testing
Q4- Dust survey at selected mine in MSHA District 7, Laboratory testing,

CY 2008
Q1- Dust survey at selected mine in MSHA District 4, Laboratory testing, Attend conference
Q2- Dust surveys at selected mines in MSHA District 5 and District 6
Q3- Dust surveys at selected mines in MSHA District 6 and District 7
Q4- Dust survey at selected mine in MSHA District 4

CY 2009
Q1- Dust surveys at selected mines in MSHA District 6 and District 7
Q2- Workshops in Districts 4, 5, 6 and 7, Attend conference
Q3- Update Small Mines Handbook, Publish and present research findings

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f) Consultants

None

g) Mission Relevance

A strategic goal of the PRL research program is to reduce the dust exposure of mine workers, with the ultimate goal of eliminating lung disease from mine workers. A review of x-ray surveillance data has illustrated an increased CWP prevalence in coal miners employed in the southern Appalachian region of the U.S. mining industry. It is suggested that rank of coal, elevated silica levels and high percentage of small mines may have a roll in this elevated risk. In small mines with less than 50 employees, the CWP prevalence was 5.6%, and in large mines, the prevalence was 2.0%. Consequently, a need for improved dust control in small underground coal mines is warranted to protect these workers at elevated risk. Research to develop new and/or improved technologies will be completed. Implementation by industry will be facilitated through: an update of a dust control handbook for small mines, publication in peer-reviewed and trade journals, the presentation of workshops in the SAR, and the development of a training module designed for incorporation into annual refresher training. Implementation of improved dust control will reduce worker dust exposure, thus lowering the prevalence of CWP in the future.

h) Project Description

This project will develop and evaluate control technologies to reduce coal and silica dust exposures for operators of roof bolting and continuous mining equipment in low coal mines. The project will commence with an investigation of the MSHA compliance data to identify the problem mines. MSHA districts will be visited to collect data specific to dust control technology and operating conditions at these mines. As a result of these preliminary investigations, mine surveys will be scheduled to collect data at the six dustiest and the six cleanest mines and to contrast the differences. The project will target areas such as ventilation techniques, spray types, equipment types, continuous miner and roof bolter operation. New dust control methods/techniques will be laboratory tested and verified in the field. Results from this work will be incorporated in an updated version of the Bureau of Mines handbook entitled “Guidelines for Dust Control in Small Underground Coal Mines” which was published in 1987. A training module will also be developed with the goal of adding this module to the annual refresher training required for coal miners.

i) Short Project Summary

This project will develop technologies to reduce exposures to respirable silica and coal dust for workers in small coal mines in the southern Appalachian region (SAR), where there exists a higher incidence of coal workers pneumoconiosis. MSHA compliance sampling data, inspector reports and dust control plans will be reviewed to characterize different mines. Field visits to the six dustiest and six cleanest mines will then be scheduled to contrast their dust control techniques and methods. Improved dust control technologies will be tested in the laboratory and then field tested in small mines. A handbook presenting dust controls for small mines will be published and a training module developed.

j) Involvement of Stakeholders

MSHA – Project Conception, Research Collaborator, Translator, Evaluator

Small Mine Operators – Research Collaborator

SME, Trade Magazines - Translator

k) Technology Transfer

N/A

l) Marketing/Dissemination Plan

The most important task of this project is to get the new dust control technology information out to the small mines where it can be implemented as soon as possible. In 1987, the Bureau of Mines published a small handbook entitled Guidelines for Dust Control in Small Underground Coal Mines by Ed Divers, Natesa Jayaraman, Steve Page, and Robert Jankowski. This handbook provided low cost dust control techniques to the small mines which were experiencing high dust concentrations. The handbook concentrated on continuous, auger, and conventional mining applications. This handbook was and still is a valuable tool to the small mine operator however, it is in need of some updating. With the assistance of NIOSH training personnel input, the handbook will be updated to include the improved dust control technology brought forth by this project and concentrate on the mining methods currently utilized in small mines today. The handbook will be available to the industry through the web and in hard copy form. Peer reviewed and trade magazine articles will be published as well as presentations given to disseminate the results to the small mines. A training module designed for inclusion in annual refresher training classes required by MSHA will be developed with coordination from NIOSH and MSHA training personnel. The module will relay the results of this project and the developed control measures to the coal miner as well as present the possible dust hazards in small underground coal mines.

DETAILED PERSONNEL PLAN

Name and Degree	Role on Project	FY2006	FY2007	FY2008	FY2009	FY2010
Onboard:						
1 Douglas E. Pollock, B.S.	P.I. – Mechanical engineer – data collection and analysis	70%	80%	80%	80%	
2 Gerrit Goodman, B.S., M.S., PhD	Mining engineer – dust and ventilation specialist, data collection and analysis	20%	20%	20%	20%	
3 Timothy Beck, B.S.	General Engineer – data collection and analysis	30%	30%	30%	20%	
4 Randy Reed, B.S., M.S., PhD	Mining Engineer- data collection and analysis	30%	20%	20%	20%	
5 Jerry Joy, B.A., M.S., M.S. Ind. Hyg.	Industrial Hygienist – data analysis	20%	20%	20%	20%	
6 Tom Mal	Technician-lab and field support	10%	30%	30%	20%	
Onboard Subtotals:		1.8	2.0	2.0	1.8	
New Hires						
1						
2						
New Hires Subtotal:						
Totals		1.8	2.0	2.0	1.8	

PROJECT BUDGET SPREADSHEET

Complete *ProjectBudget.xls* and attach as an appendix to this form.